Meetings

Brain Mechanisms and Vision: Subcortical Systems

At a conference on subcortical visual systems, held at the Massachusetts Institute of Technology in June 1969, some two dozen workers, including anatomists, physiologists, and psychologists, departed from the traditional emphasis upon the geniculostriate pathways as *the* visual system.

Among the anatomists a feeling of solidarity developed as it became evident that, in animals of each vertebrate class, fibers from eye to brain terminate in a generally comparable fashion within specific regions of thalamus and midbrain. Karten (M.I.T.) carried the theme of homologies to an extreme that would have been considered heretical a few years ago: that in reptiles, birds, and mammals there are two parallel visual pathways ascending to the endbrain. One route, from retina to lateral geniculate to cortex, has now been identified in birds as well as in mammals. The other route, from tectum to posterior thalamus to telencephalon, recently found in reptiles and birds, was tentatively compared to the ascending pathway to the extrastriate visual cortex of mammals. This evolutionary perspective on visual cortex complements the classical view that extrastriate visual regions further elaborate visual coding processes of striate cortex, as shown by the electrophysiological studies of Hubel and Wiesel on visual cortex of cat and monkey. The new anatomical studies seem to cast the extrastriate cortex in the interesting role of an integrator of information from geniculofugal and tectofugal systems. Karten's proposed homologies, which seemed agreeable to many participants, provide some antidote for the entrenched frustration of those anatomists and physiologists who have been impressed by the overt differences between brains of reptiles and those of mammals.

At the same time that a consistent view of vertebrate visual connections was providing a framework for discussion of visual functions, other investigators brought to attention some facts about neural plasticity which added a mysterious dimension to the whole problem. M. Keating (University of Edinburgh) added an important chapter to the story of visual development of amphibia as was previously written by R. Sperry and by M. Gaze. Although in *Xenopus* retinotectal connections are determined during early development, the pattern of tectotectal connections appears to be determined by visual experience at about the time of metamorphosis. The tectotectal system develops a reversed topographic order when the tadpole larva is reared with one eye rotated surgically by 180°. These and other data led Keating to a tantalizing hypothesis: Distant populations of neurons that are simultaneously activated by the same visual stimulus (via opposite eyes) can selectively grow, or retain, synaptic associations. G. Schneider (M.I.T.) also inferred developmental neural plasticity from the fact that destruction of the optic layers of the tectum in the baby hamster fails to produce the dramatic loss of "orienting" responses toward visual objects, which is characteristic of tectal removal in the adult. Schneider suggested that this plasticity depends upon the abnormal growth of retinal fibers into the remaining deep layers of the tectum. These early tectal lesions also led to the formation of a new and unexpected retinal projection to the nucleus lateralis posterior of the thalamus. Since the tectum itself normally sends a projection to this region, the formation of a "short cut" implies that retinofugal fibers are coded so that when they fail to contact their normal target area they can search out the next relay station. I. Diamond (Duke University) suggested that such a system-specific coding process could provide a mechanism for evolutionary elaboration of new pathways.

While the anatomists were complicating the visual system wiring diagrams by noting rich interconnections among thalamic, midbrain, and cortical components, some of the participants found that behavioral evidence demands such multilevel interactions. A neuroethological study of toad-feeding behavior by J. P. Ewert (Darmstadt Zoological Institute) implied that the visuomotor functions of the optic tectum are modulated by thalamic influences. Direct evidence for such a process emerged from the observations that lesions of the pretectal region of the posterior thalamus can dramatically disinhibit a toad's feeding responses, even toward large objects that would normally be avoided. Inasmuch as small pretectal lesions sometimes produced quite restricted zones of disinhibition within the visual field, Ewert concluded that the toad thalamus exerted a topographically ordered influence upon the optic tectum. Furthermore, he noted that these lesions nearly abolished the normal course of habituation of prey-orienting movements of toads, a process that hitherto had been considered as intrinsic to the tectum. Another kind of influence of rostral visual structures upon the tectum was demonstrated for mammals also. The reports of B. Wickelgren and P. Sterling (Harvard Medical School) and of C. Michael (Yale Medical School) indicated that much of the visual selectivity of tectal neurons in cats and squirrels is derived from corticotectal rather than from retinotectal pathways. Although the theoretical complications of these interactions remain to be unraveled, the essential facts are in good agreement with the neurobehavioral studies of J. Sprague (University of Pennsylvania Medical School) who was among the first to emphasize cortical-tectal interaction in mediation of visually guided behavior. Taken together, these studies reinforced a healthy respect of the participants for the functional unity of the visual system.

The meeting did not end on this ambiguous note, but with the achievements of N. Humphrey (Oxford University) who has painstakingly trained a destriate monkey to localize and grasp small objects. It seemed reasonable to suppose that this residual visuomotor ability involves the optic tectum, since the monkey (trained by psychophysical test methods) seemed to detect visual objects on the same basis that single neurons of the monkey tectum were found to do: according to their position, size, and brightness. The monkey could select one of two stimuli that differed along any of these dimensions, but could not categorize them with respect to shape or color. Humphrey's results harmonized with a report of C. Trevarthen of Caltech (submitted to, but not read at, the conference) that human subjects with forebrain commissures transected were able to compare relative positions, velocities, sizes, or brightness values of objects presented within opposite hemifields, but that they could not match objects in terms of color or shape. Even among advanced primates the tectofugal system seems to process information about location, size, or movement of objects, whereas their identification as shapes or colors demands the cooperation of the geniculofugal system. Although most of the information presented at this conference was new, the participants were, on several occasions, gratified by the extent to which diverse pieces of evidence fell together into a cohesive picture of the vertebrate visual system.

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Forthcoming Events

July

19–24. American Assoc. of **Clinical Chemists**, 22nd natl., Buffalo, N.Y. (D. A. Pragay, P.O. Box 38, Buffalo 14215)

20–22. American Inst. of **Aeronautics and Astronautics**, Detroit, Mich. (W. I. Marble, 2 Pennsylvania Plaza, New York 10001)

20–22. Society of **Automotive Engineers**, Detroit, Mich. (W. I. Marble, 2 Pennsylvania Plaza, New York 10001)

20–22. Conference on the **Fatigue Problem**, Boston, Mass. (J. A. Fellows, American Soc. for Metals, Metals Park, Ohio 44073)

20–22. Society of Mechanical Engineers **Reliability and Maintainability** Conf., Detroit, Mich. (W. I. Marble, 2 Pennsylvania Plaza, New York 10001)

20–24. Association for the Study of **Animal Behavior**, Birmingham, England. (S. Dimond, Dept. of Psychology, University College, Cardiff, Wales)

20–24. Symposium on Coastal **Geodesy**, Munich, Germany. (G. W. Lennon,